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Buffer overfill and underfill prevention method for SDH telecommunication system - changing de-synchroniser operation mode at terminating end of SDH path when failure is detected

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GB 2312353	A	19971022	GB 967891	A	19960416	199745 B
EP 802643	A2	19971022	EP 97301959	A	19970321	199747
AU 9718909	A	19971023	AU 9718909	A	19970416	199750
NO 9701712	A	19971017	NO 971712	A	19970414	199801
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GB 2312353	B	20001206	GB 967891	A	19960416	200065
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Abstract (Basic): GB 2312353 A

The overfill/underfill prevention method involves detecting a synchronisation failure or wander and temporarily changing the mode of operation of a de-synchroniser (27) at the end of the SDH path, where data is read into a buffer (24). Pref. a synchronisation status message byte (SSMB) is monitored (21) and used as an indicator of the quality of the incoming bearer timing.

ADVANTAGE - USE/ADVANTAGE - For preventing overfill/underfill

caused by synchronisation failure or excessive amount of wander.
Prevents data corruption.
Dwg.2/4

Title Terms: BUFFER; OVERFILL; PREVENT; METHOD; TELECOMMUNICATION; SYSTEM; CHANGE; DE; SYNCHRONISATION; OPERATE; MODE; TERMINATE; END; PATH; FAIL; DETECT

Index Terms/Additional Words: SYNCHRONOUS; DIGITAL; HIERARCHY

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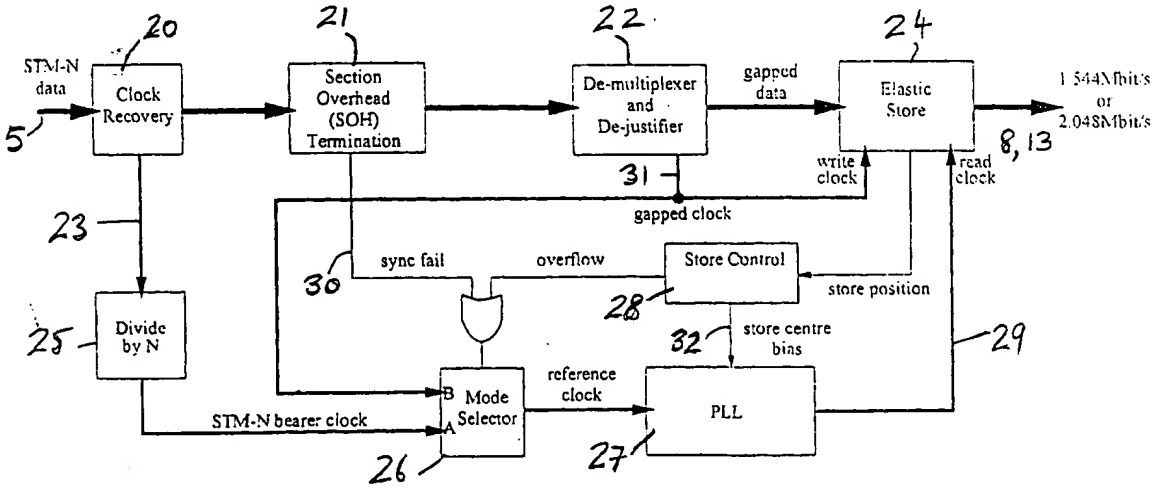
(54) SDH desynchronizer

(57) In an SDH telecommunications system a method of overcoming a buffer overfill/underfill problem consequent upon either a synchronisation failure or an excessive amount of wander comprises detecting such failure or wander and as a result temporarily changing the mode of operation of a de-synchroniser at the terminating end of the SDH path to prevent the overfill or underfill of the buffer.

"The Synchronisation Status Message Byte (SSMB) is used as an indicator of the quality of the incoming bearer timing."

Figure 2



EP 0 802 643 A2

Description

The present invention concerns digital telecommunications data transmission systems and is particularly concerned with data transmission involving what his known as the synchronous digital hierarchy (SDH). SDH involves the multiplexing of lower rate signals into a hierarchy of higher rate signals which are all nominally synchronous.

A key requirement for SDH equipment is to offer compatibility with functions provided by the existing plesiochronous digital hierarchy (PDH) network. Accurate network timing is needed for some applications, where phase information is critical in the timing component of the delivered signal. Such timing is usually transported and delivered in existing networks, as a component of information within the primary rate traffic signal. Normally the primary rate traffic signal is at 2Mbit/s. For the purpose of this specification it will be assumed that the 2Mbit/s signal is the primary rate signal. However this is not a factor in the actual basis of the present invention as in principle such timing can be transported and delivered at any frequency or can be derived from any constant digital bit rate, and then rescaled to the appropriate frequency for local use.

Where accurate network timing is lost the consequence is either a reduction of performance margins at some point in the network, leading to an increased risk of digital errors as normal parameter variation occurs, or else to errors being directly introduced - usually at a low rate of occurrence, but nontheless unacceptable for critical applications.

For some applications the delivery of accurate network timing is now widely accepted as being unavailable in SDH, at least in the way in which timing is transported in the PDH network, as a component of the 2Mbit/s signal carried across the network.

In SDH the 2Mbit/s signal is transported in a virtual container (VC), whose location in time in relation to a frame timing reference, is defined by a pointer. Pointer adjustments in SDH produce phase disturbances in the timing component of the delivered 2Mbit/s, which can cause problems in establishing network synchronisation, for example with exchange synchronisation arrangement. Good timing delivery is possible in principle over a point - point link, because pointers are not expected to change here, but in real networks it is necessary to allow for transmission via add-drop muxes, hubs, cross-connects, etc. all of which may introduce changes in the values of pointers attached to VCs.

Discussions are continuing to establish accepted standards on ways to modify SDH in order to overcome this problem, but techniques proposed so far generally require that all nodes along an SDH path be equipped with conforming equipment, which effectively means that these techniques be approved as standards. Such solutions may be impractical because of the existence of significant quantities equipment to the initial standard.

In the absence of such new techniques, the distribution of network timing over SDH networks is assumed to be via the SDH (usually optical) bearers, with dedicated clock outlets driven at primary rate - 2048 or 1544 kbit/s as appropriate for the territory - from the received bearer timing after rescaling from its transmission bit rate. Only one or two such outlets would normally be fitted per equipment and they would be usable only by equipment which had been designed to accept timing via ports which are separate from data ports.

These outlets would be of no practical use in one of the most likely situations, where a customer is connected to an SDH element in the network, via a conventional 2 Mbit/s link over for example a copper pair, an optical fibre or a radio bearer. In these cases the provision of another 2 Mbit/s connection just for timing purposes would be uneconomic; in effect those customer services which require network-synchronous operation would suffer a severe cost penalty.

In the applicants earlier GB Patent 2,257,603 there is described an arrangement in which buffers are provided at the final termination of the SDH path in the path of the extracted 2 Mbit/s or primary date data signal, in order to smooth out short term phase disturbances. However, in certain circumstances such a buffer can be overloaded and thus overflow and this in turn will result in data corruption. That Patent discloses an arrangement in which there is an overflow detector to prevent such a buffer from overflowing.

In SDH, a method exists to carry primary rate signals, at 1.544Mb/s or 2.048Mb/s, within a synchronous frame structure. The technical details for this process are well documented in International Standards (ITU TSS Recommendations G.707, G.708 and G.709). However, these signals can, under normal conditions, experience phase steps of up to 8μs in a period of a few seconds. If the externally connected exchange equipment is intolerant to sudden changes in phase, the signal will be rejected as faulty. To prevent this problem a primary rate re-timing buffer can be employed at the terminating end of an SDH traffic path which smooths out short term phase disturbances. Using a pointer cancelling technique within these buffers (see the Applicants Patent Application 9509216.9), an operator can pass primary rate timing from a network synchronised to one frequency (fl), via an SDH network synchronised to a difference frequency (f2). If fl equals f2 then the primary rate timing can be carried via the SDH bearer (see the Applicants GB Patent 2,257,603)

However, these techniques may not be adequate when a long term and severe synchronisation failure occurs in the SDH transmission system. In such a situation the re-timing buffers will tend to fill or empty in one direction and therefore a mechanism is required to avoid an overflow or underflow occurring and causing loss of traffic. Even if the synchronisation failure does not last long enough to threaten an overflow/underflow, nevertheless the buffer can be left in a less than ideal position

by being near either its upper or lower capacity limits.

Thus according to the present invention a method of overcoming the buffer overfill/underfill problem comprises detecting a synchronisation failure and as a result temporarily changing the mode of operation of a de-synchroniser at the terminating end of the SDH path to prevent overfill or underfill of the buffer.

The temporary change may introduce the phase disturbances which the buffer had originally been intended to eliminate but in the context of synchronisation failure this is considered to be acceptable.

According to an aspect of the present invention the means for detecting the synchronisation failure comprises a special overhead time slot within the primary rate signal.

More particularly in accordance with International Standards an overhead information byte within the STM-N frame structure is reserved for carrying a Synchronisation Status Message Byte (SSMB). This message byte is used to indicate the quality of the synchronisation being carried on the STM-N bearer. An SDH multiplexer equipment can, by monitoring these bytes on all incoming STM-N ports, select the signal with the highest synchronisation quality as the equipment timing source. If a severe synchronisation failure occurs in the SDH network this will be represented by a low quality SSM code.

A recent addition to International Standards has been the extension of the above synchronisation quality signalling to primary rate traffic signals. An overhead timeslot has been allocated to carry a Synchronisation Message Byte which can indicate that the primary signal rate no longer carries high quality timing following a severe synchronisation failure in the SDH network.

How the invention may be carried out will now be described by way of an example only and with reference to the accompanying drawings in which :

Figure 1 is a schematic representation of an SDH Network;

Figure 2 is a block diagram illustrating one embodiment of the present invention;

Figure 3 illustrates the data flows and clock pulses at the points indicated; and

Figure 4 is a graph illustrating the fill/unfill performance characteristics of the buffer included in the embodiment of Figure 1.

Referring to Figure 1 an SDH network comprises a network timing source 1 which feeds an eg. 2MHz signal into an exchange 2. The exchange feeds 2 Mbit/s signals over N, two as shown, signal connections 3 into an SDH multiplexer 4. The multiplexed STM-N signal is then fed over an SDH bearer 5 to an SDH demultiplexer 6. The exchange 2 is also connected to the SDH multiplexer 4 by a control line 7 which synchronises the bearer 5 at the 2MHz clock rate. Within the demultiplexer 6 the signal is converted back into the 2 Mbit/s primary rate format and fed over lines 8 to an exchange 9. A line 10 corresponding to line 7 is provided for deriving timing information from the bearer.

In addition and by using a retiming arrangement, a third party user can use the SDH network for conveying timing and other data from a private network 11. A private timing source 10, which is not synchronous with the network timing source 1, transmits timing signal, i.e. primary rate signals at 1.544Mbit/s or 2.048Mbit/s through a link 12 to the SDH multiplexer 4. After demultiplexing the timing signals are conveyed along line 13 to the private network 14.

Referring to Figure 2, this shows in more detail the demultiplexing, desynchronising and buffer arrangements of the present invention.

A multiplexed STM-N signal 5 is input to a clock recovery circuit 20 where a clock signal is stripped off on to line 23, divided by N at a divider 25 and the resulting STM-N bearer clock fed to a mode selector 26.

The clock receiving output is passed to a Section Overhead (SOH) termination 21 and thence to a demultiplexer and de-justifier 22 the output from which is fed to an elastic store or buffer 24 which in turn outputs the 1.544Mbit/s or 2.048Mbit/s signal at 8, 13.

A phase locked loop (PLL) 27 is operative to take as an input the bearer reference clock signal taken from 20 and to output a modified read clock signal via line 29 for use in retiming data out of the elastic store or buffer 24. The phase locked loop signal on 29 can be derived in a number of ways determined by the two-position mode selector 26, which has inputs A and B, and a store control or monitor 28 by which the fill state of the store or buffer 24 is monitored.

Any temporary loss of synchronisation or normal amounts of wander in the SDH network will be accommodated within the elastic store 24. If SDH network synchronisation is lost for a long period of time the effect would eventually be an underflow or overflow of the elastic store 24.

It is this condition with which the present invention is concerned.

The elastic store 24 receives 'gapped' data from the de -multiplexer 22 which has the correct average data rate but contains blank periods due to removed overhead time slots and the dejustification process. Thus the store or buffer 24 absorbs temporary phase transients cause by the extraction of overhead and justification bytes.

When the re-timing buffer 24 is operating in a fault-free, synchronous network the read clock 29 for the final data output is derived from STM-N bearer 23 by having the mode selector in Figure 1 set to position A. When used to provide a primary rate re-timing function the elastic store incorporates extra storage capacity to handle around 40 microseconds of network wander.

However, when a severe synchronisation fault occurs in the SDH network, an SSM change is received in the Section Overhead (SOH) processor 21. When the

incoming SMB code falls below a threshold value a sync fail signal is generated by 21 and fed to the mode selector 26 via line 30 to cause the mode selector 26 to change to position B. In this position the de-synchroniser PLL 27, uses the gapped 'write' clock signal at 31 as a reference so that the 'read' clock signal at 29 is continually adjusted, so as to maintain the level of buffer fill at the position indicated by the store monitor control 28 at the time when the fault occurred. This level is set by a store centre bias signal 32 from the elastic store and informs the PLL 27 of the nominal operating point to be maintained. The change of the SSM is also signalled in the SMB carried within the outgoing primary rate signal 8,13 thus enabling external equipment to recognise the degraded condition of the signal's timing quality.

Selection of Mode B can also occur without a sync failure but when an excessive amount of wander is present in the SDH network. This wander can cause the elastic store 24 to fill-up/empty and by temporarily switching to Mode B, with the store centre bias 32 offset to a point further from the store limits, any overflow/underflow can be avoided.

By using the technique described herein, the primary re-timing buffer 24 can accommodate network wander without any transitory phase disturbances on the output data port. When a severe synchronisation failure occurs in the SDH network the buffer fill position is maintained. Short term phase disturbances may occur in this condition but the failure event is signalled via the SMB. Upon recovery of network synchronisation, wander is accommodated once more without phase disturbance.

Figure 4 shows the average buffer fill before and after a network synchronisation disturbance and it also shows the avoidance of buffer overflow in a synchronised network by temporary selection of mode B with an offset store centre bias. Figure 3 shows the outputs at the points indicated in Figure 2.

Claims

1. In an SDH telecommunications system a method of overcoming a buffer overfill/ underfill problem consequent upon either a synchronisation failure or an excessive amount of wander comprises detecting such failure or wander and as a result temporarily changing the mode of operation of a de-synchroniser at the terminating end of the SDH path to prevent the overfill or underfill of the buffer.

2. A method as claimed in Claim 1 in which the primary rate timing is derived either from the STM-N bearer or the average data rate in response to the quality of incoming bearer timing as represented by the Synchronisation Status Message Byte (SSMB).

3. A method as claimed in Claim 1 or 2 in which the re-timing mode change of the outgoing primary rate data signal is effected by use of the incorporated SMB synchronisation quality indicator.

4. A method as claimed in any previous claim in which a variable store bias control is provided to create an average rate read clock out of an SDH de-synchroniser which can have different fixed phase positions for normal operation.

5. In an SDH telecommunications systems a means for overcoming a buffer overfill/underfill problem consequent upon either a synchronisation failure or an excessive amount of wander which comprises means for detecting such failure or wander and means for temporarily changing the mode of operation of de-synchronisers at the terminating end of the SDH path in response to the detecting means to prevent the overfill or underfill of the buffer.

6. Apparatus as claimed in Claim 5 in which the primary rate timing is derived from either the STM-N bearer or the average data rate in response to the quality of incoming bearer timing as represented by the Synchronisation Status Message Byte (SSMB).

7. Apparatus as claimed in Claim 5 or 6 in which the re-timing mode change of the outgoing primary rate data signal is effected by use of the incorporated SMB synchronisation quality indicator.

8. Apparatus as claimed in any of claims 5 to 7 in which a variable store bias control is provided to create an average rate read clock out of an SDH de-synchroniser which can have different fixed phase positions for normal operation.

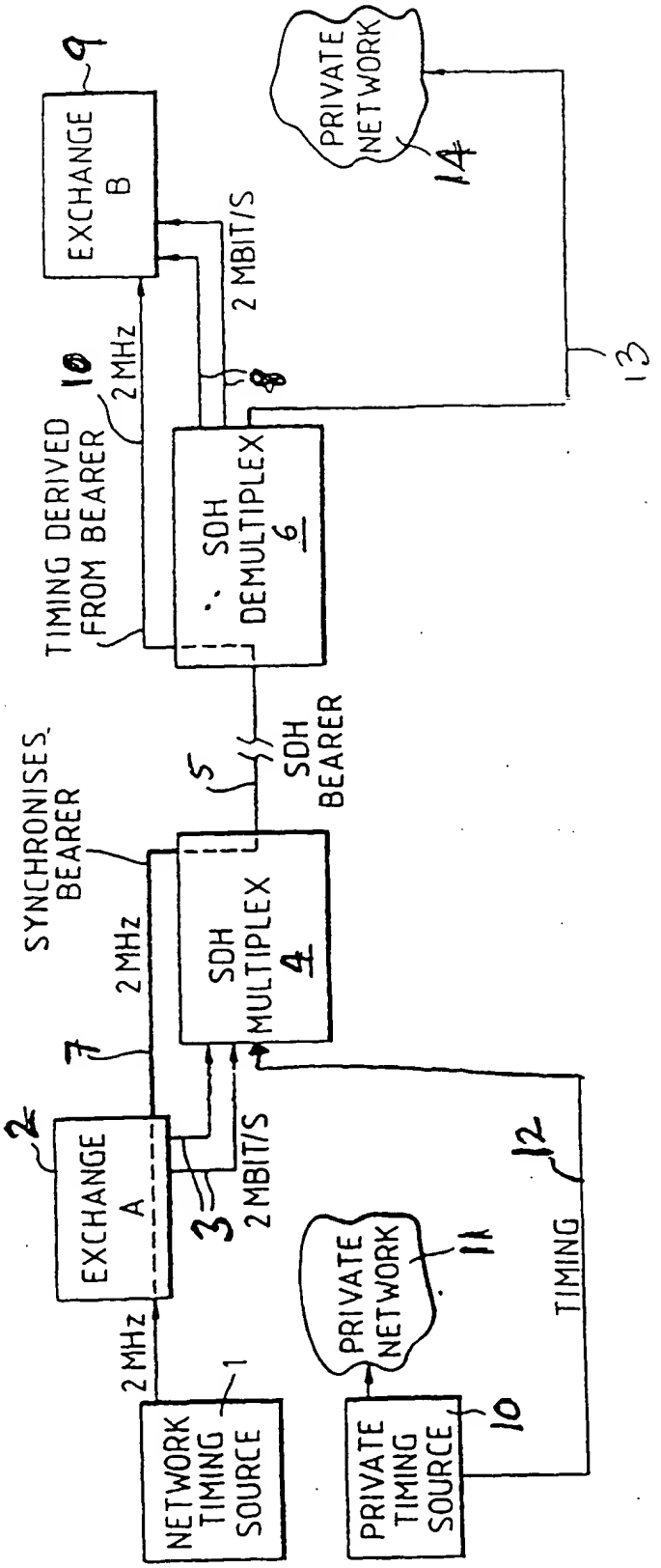
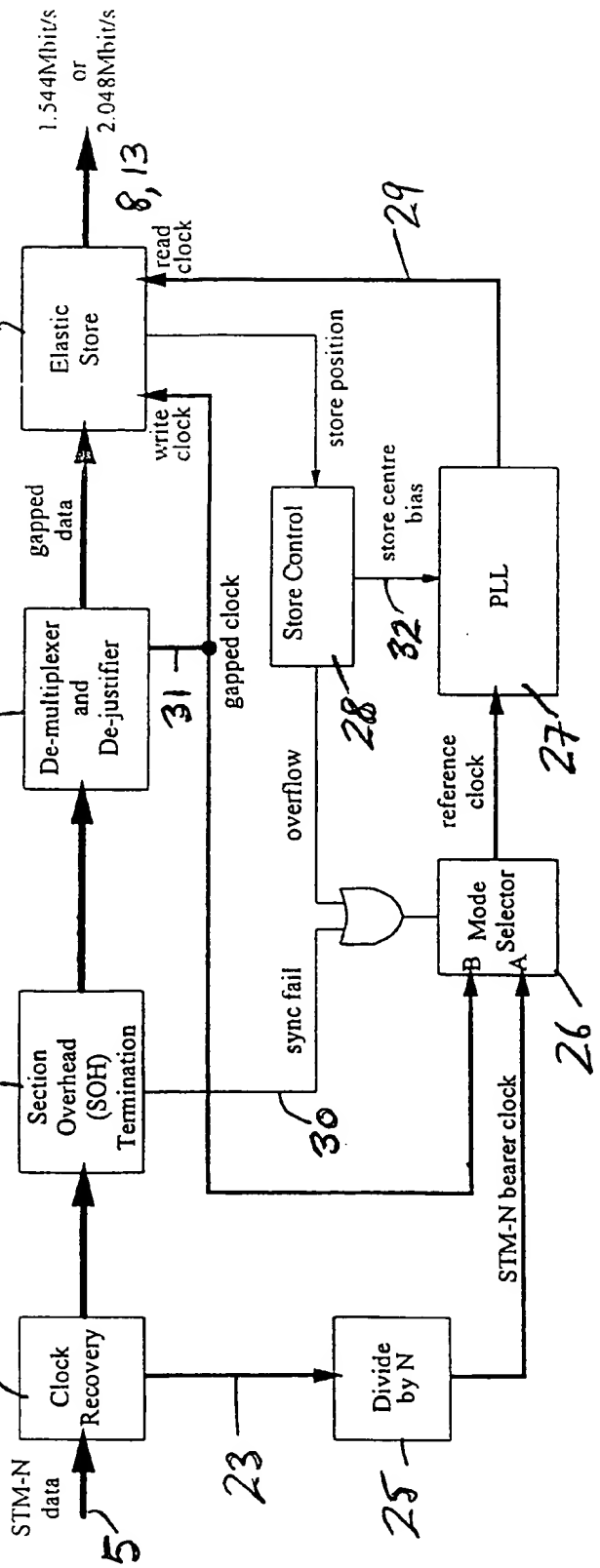

NETWORK TIMING SOURCE
1
2 MHz
EXCHANGE A
2
3
2 MBIT/S
SYNCHRONISES BEARER
2 MHz
7
SDH MULTIPLEX 4
5
SDH BEARER
SDH DEMULTIPLEX 6
TIMING DERIVED FROM BEARER
2 MHz
10
2 MBIT/S
8
EXCHANGE B
9
PRIVATE NETWORK
14
13
PRIVATE NETWORK
11
PRIVATE TIMING SOURCE
10
TIMING
12

Fig 1

Figure 2



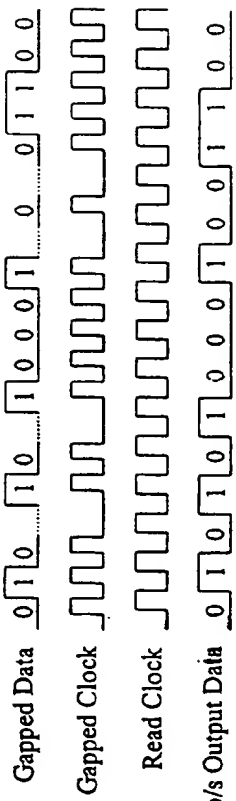
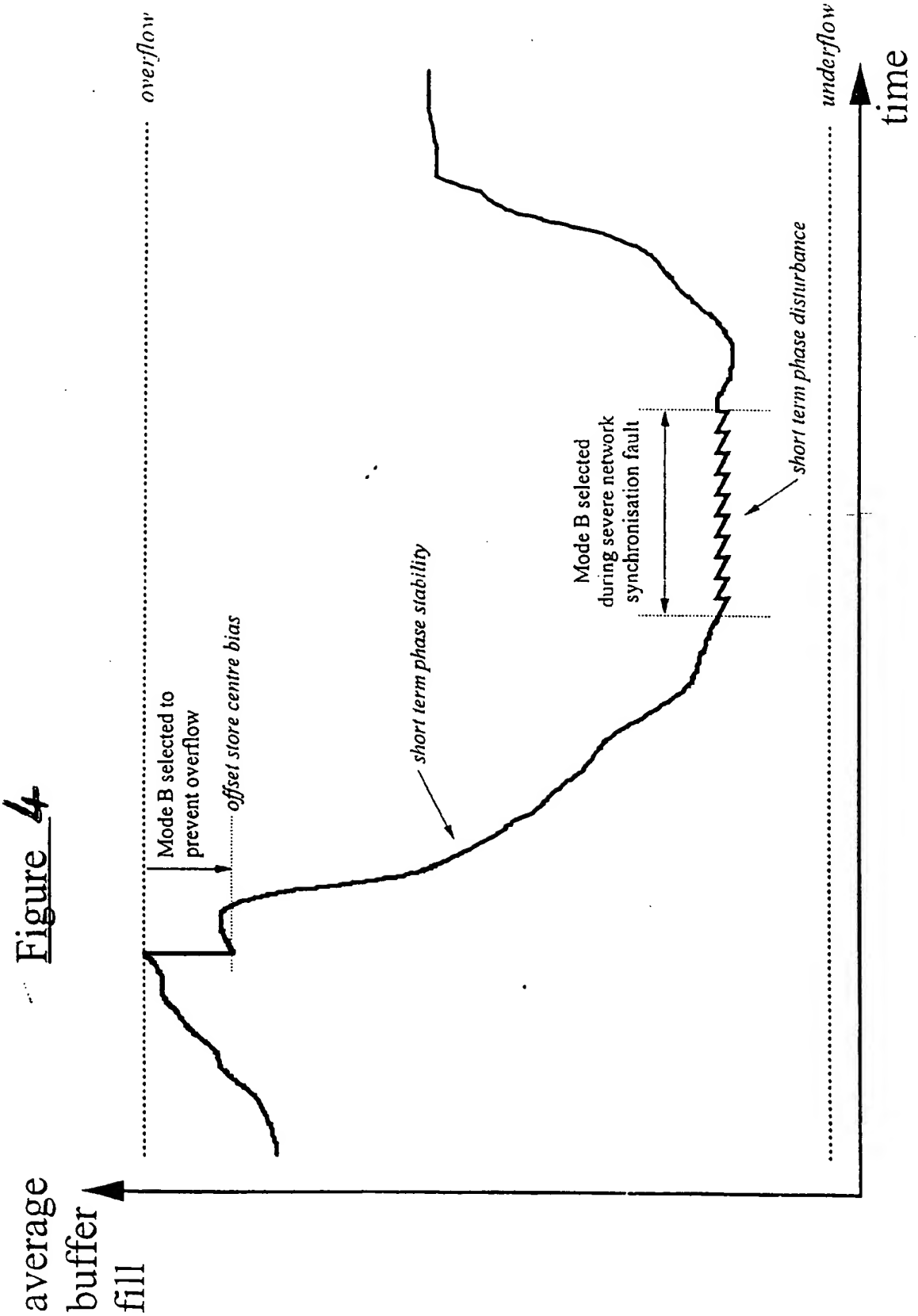


Fig 3

Figure 4


average buffer fill
overflow
underflow
time
Mode B selected to prevent overflow
offset store centre bias
short term phase stability
Mode B selected during severe network synchronisation fault
short term phase disturbance